Space Weather Technical Forecast

Issued on Monday, 12 September 2022 at 13:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increased Chance of M-class and X-class flares. Ongoing Active electron fluence. Risk of CME arrival on 13 or 14 September. Very slight chance of S1 proton storm.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with a number of mid-level C-class flares observed, mainly from AR3098, but also from AR3101. Both these regions appear to be evolving in complexity and contribute the most to the risk of M-class and X-class flares. AR3100 is also complex and have developed rapidly, but appears to be inactive compared to the two previously mentioned regions. There are 5 remaining benign and magnetically simple sunspot regions on the visible disc. A filament eruption and subsequent CME from the vicinity of AR3098 appears to have resulted in a proton enhancement in the near Earth environment. This will be fully analysed when sufficient imagery becomes available.

Solar Wind / Geomagnetic Activity: The solar wind speed at L1 has followed a declining trend as the Earth exits the high speed stream of coronal hole 24, with winds now at background levels. Solar wind was around average, but showed a brief jump around 12/0800UTC, which is presumed to be the earth leaving the solar wind environment. The total magnetic field strength was generally weak, but with the north-south component mainly negative throughout. Phi angle was mainly positive (away from the Sun), with brief positive fluctuations early in the period. Geomagnetic activity was Quiet to Unsettled, with one Active interval between 11/1500-1800UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, started increasing above the normal background levels at 11/2100UTC reaching 7 pfu by 12/1200UTC, due to the forecast effects of a filament eruption on 11 September. High energy electron flux varied from moderate to high, with a sharp peak of 2.16e4 pfu at 11/1605UTC. . The corresponding 24-hour electron fluence remained above Active (1e8 integrated pfu) with a falling then rising trend, resulting in a 12/0001UTC observed value of 3.29e8 integrated pfu.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to increase from Low levels through the forecast period, perhaps reaching Moderate or Strong levels due to the potential flares from three sunspot regions, and one just about to rotate onto the visible disc.

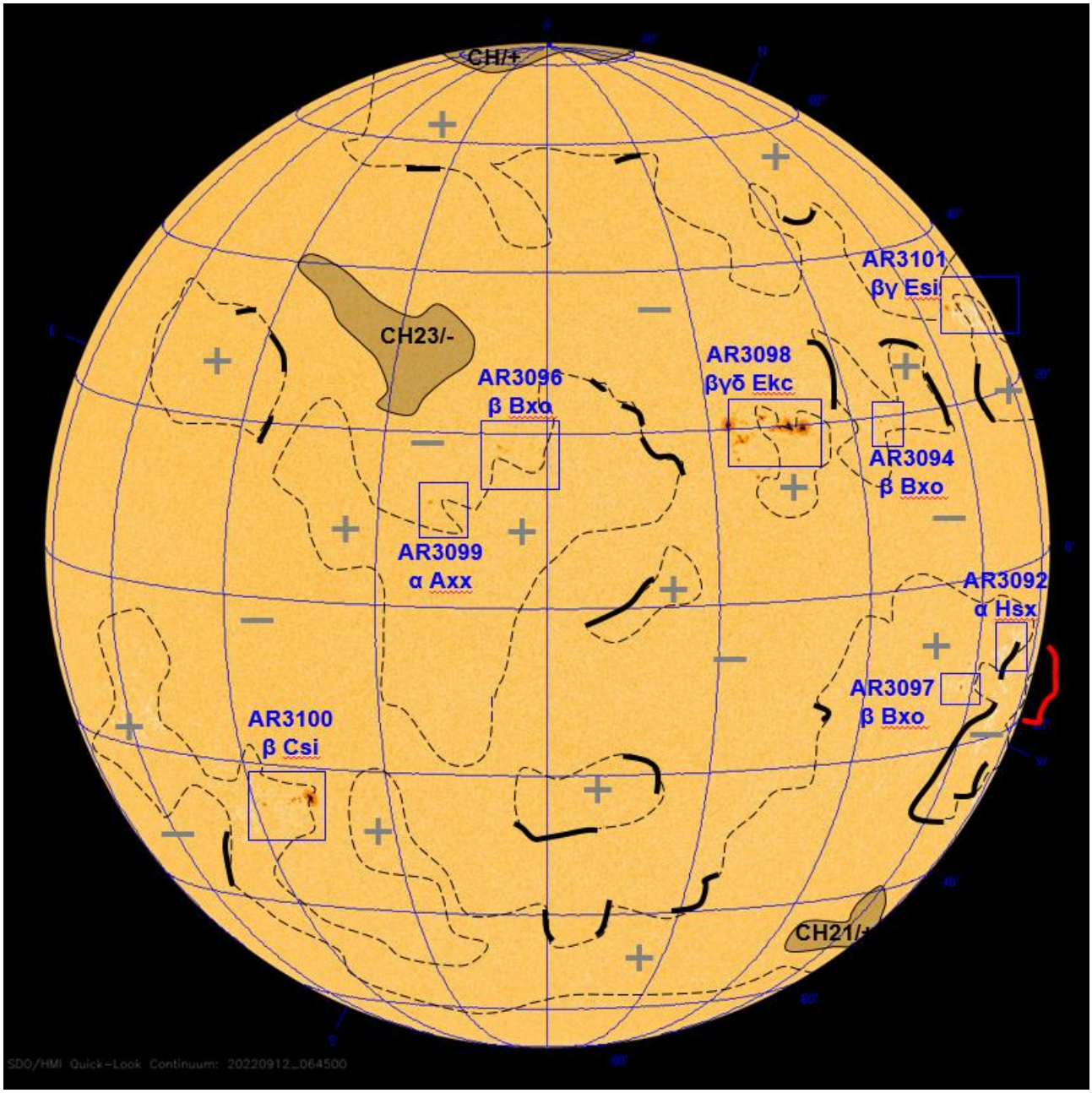
Solar Wind / Geomagnetic Activity: A CME which was observed leaving the Sun on 11 September may arrive at Earth on 13 or 14 September, although confidence is low, as insufficient imagery is currently available to model the feature accurately. Otherwise no further features are expected to affect the Earth, with coronal hole 20 in the northwest quadrant now appearing to have faded. Geomagnetic activity is forecast to be mainly Quiet to Unsettled on day 1 and much of day, with mainly Active and a chance of G1/Minor Storms late on day 2 or during day 3, due to the risk of a CME arrival, although this aspect of the forecast is low confidence.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels, but with a very slight chance of exceeding the threshold, due to the increased sunspot complexity and recent CME observations.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 12/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

A filament eruption was observed leaving the north centre of the Sun around 11/1200UTC. Initially it was unclear whether this had left the Sun or had been reabsorbed, with LASCO imagery limited, due to a data gap. STEREO A imagery although unclear indicates that a potentially Earth-directed CME has been emitted. STEREO A imagery is limited and is currently of little analytical use. The presumption of a CME however is supported by a sudden increase in the proton flux subsequent to the filament eruption, suggesting a 'snowplough' effect of proton enhancement ahead of a CME. In the absence of a sufficient analysis an estimate of a three day transit time would allow for an arrival on either late on 13 September or during 14 September, with a risk of G1/Minor Storms, although the forecast of arrival time or potential impacts are low probability.

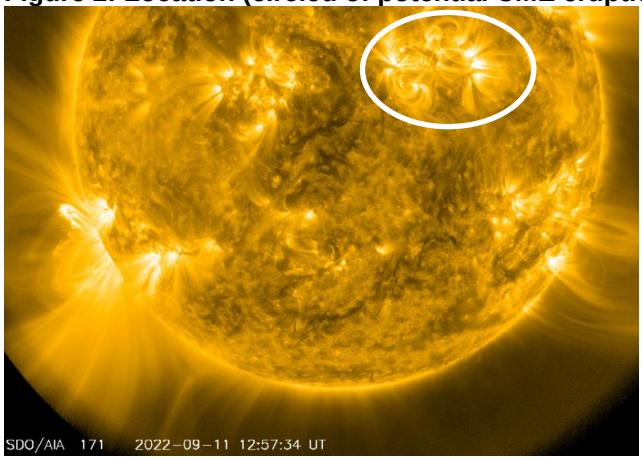
Otherwise coronal hole 22 was a weak feature which appears to have closed, with no significant impact expected on solar wind speeds. The high speed stream from coronal hole 23 is then due to connect with Earth after the end of the period.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled on day 1 and much of day 2, with a mainly Active and a chance of G1/Minor Storms wither late on day 2 or during day 3, due to the risk of a CME arrival, although this aspect of the forecast is low confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	30	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

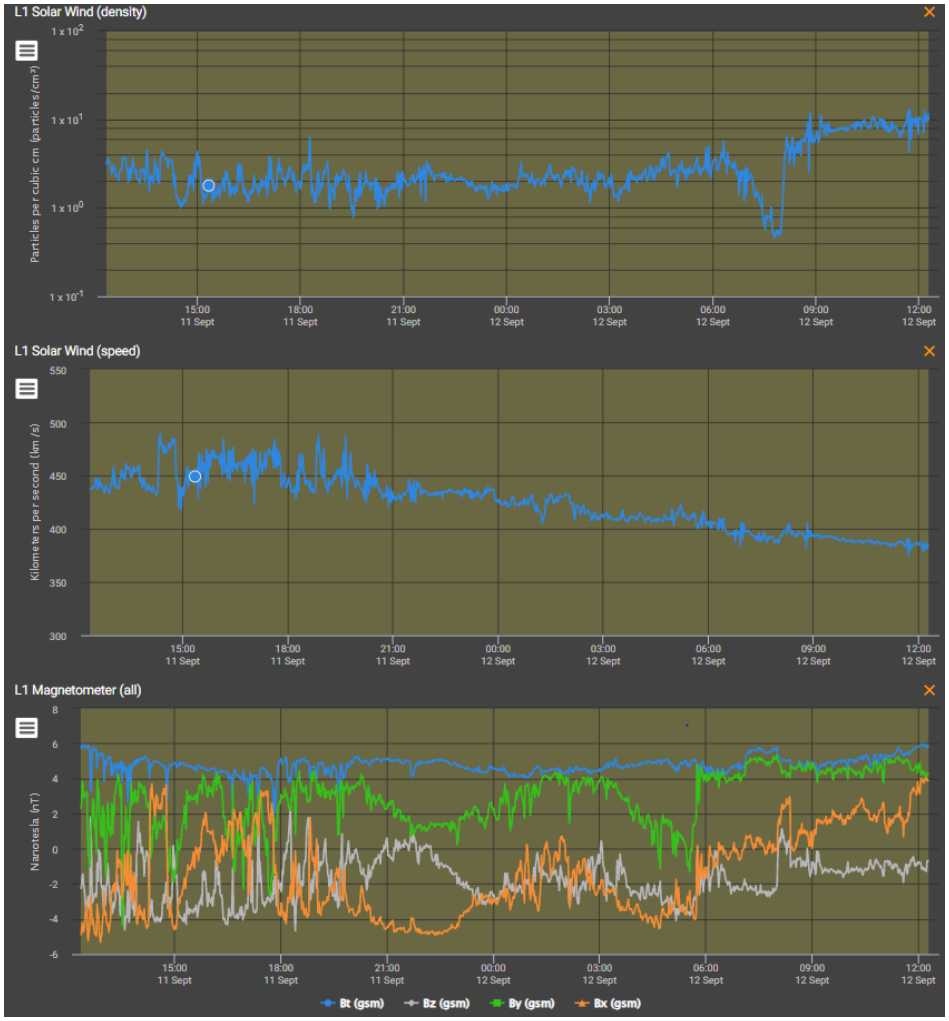
Figure 2: Location (circled of potential CME eruption



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 3: Recent solar wind parameters



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

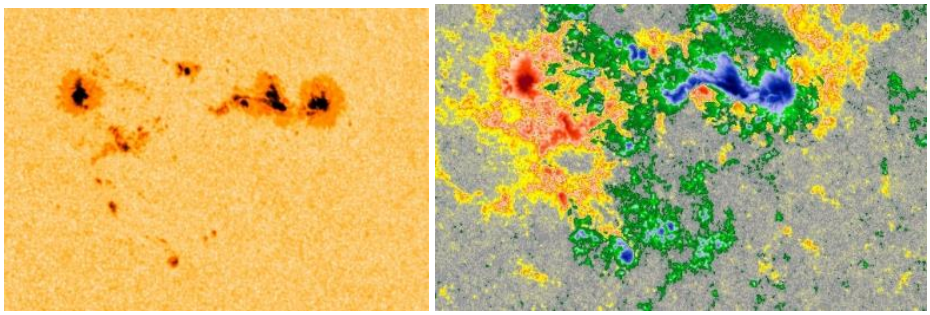
Radio Blackouts - X-Ray Flares:
The most significant sunspot region on the disc is AR3098 (Ekc/βγδ) which despite evolving into a delta spot over the last 24 hours, has not produced any significant flares. The region however may have been responsible for a CME eruption on 11 September, so carries an enhanced flare risk.

AR3100 (Csi/β) on the northwest limb and AR3101 (Esi/βγ) towards the southeast limb are both showing signs of development, but neither has produced significant activity. The remaining regions are either weak, table, or relatively inactive.

Solar activity is expected to be mainly Low, but with an increased risk of M-class and X-class flaring due to the evolution of the three most significant sunspots. There is also the risk of enhanced activity from ex-3088 which is just starting to rotate across the southeast limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: AR3098 (SDO HMI intensitygram and magnetogram)



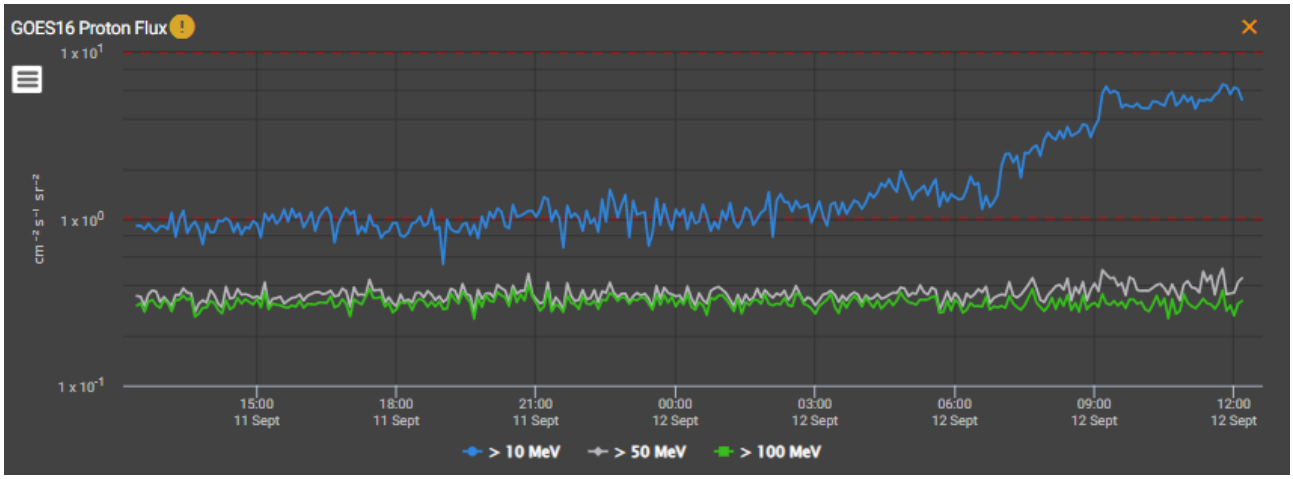
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10MeV) has undergone a marked enhancement over the last 18 hours, due to the filament eruption from the vicinity of AR3098 and subsequent proton enhancement ahead of the feature which has been observed at Earth.
As the filament has emanated from a complex sunspot region and a marked rise has already been observed, the risk of the S1 threshold being reach has been increased, as an eruption from AR3098 present a significant increase in the proton flux.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-16 proton flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

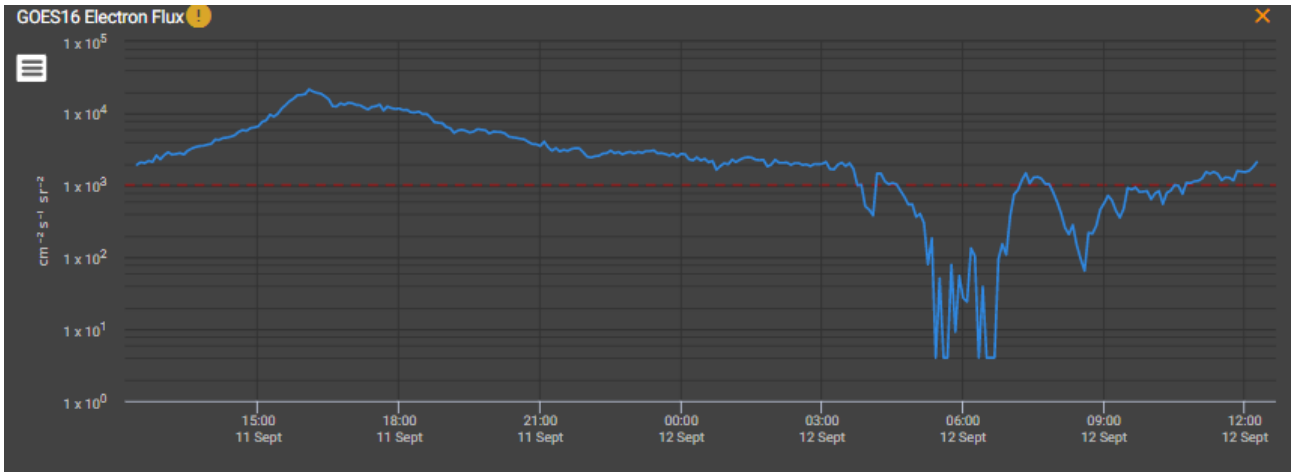
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux has varied between moderate and high levels through the last 24 hours. Part of the peaks could be due to proton contamination, but otherwise the diurnal peaks are expected to slowly fall as the radiation in the belts slowly dissipate as the solar wind eases. A potential CME arrival on either 13 or 14 September may lead to further losses due to geomagnetic enhancements, with a chance of a subsequent increase due to the injection of CME particles into the belts.

Electron fluence values are expected to follow a steadily declining trend through the next four days, although this may level out later in the period due to the balance between losses due to geomagnetic activity and inputs from any CME.

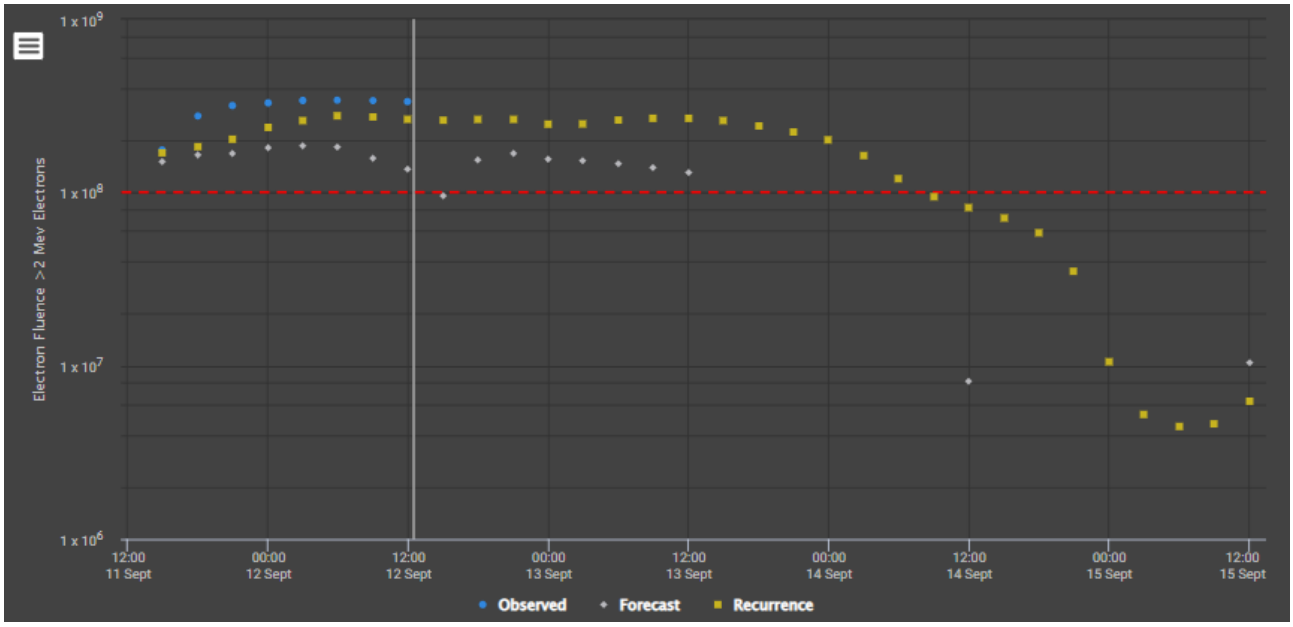
GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	70	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 6: GOES 16 electron flux and MOSWOC REFM model



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.